Claims

[c1] 1.A barrier coating material, comprising:

(a)about 15 atom % to about 95 atom % chromium; and

(b)about 5 atom % to about 60 atom % of at least one element selected from the group consisting of rhenium, tungsten, ruthenium, and combinations thereof.

[c2] 2.The barrier coating material of claim 1, further comprising about 1 atom % to about 35 atom % of at least one element selected from the group consisting of nickel, cobalt, iron, and combinations thereof.

[c3] 3.The barrier coating material of claim 1, further comprising about 1 atom % to about 35 atom % aluminum.

[c4] 4.The barrier coating material of claim 1, wherein the level of chromium is in the range of about 25 atom % to about 60 atom %.

[c5] 5.The barrier coating material of claim 1, wherein the level of tungsten is in the range of about 5 atom % to about 20 atom %.

[c6] 6.The barrier coating material of claim 5, wherein the level of tungsten is in the range of about 10 atom % to about 15 atom %.

[c7] 7.The barrier coating of claim 5, further comprising about 1 atom % to about 35 atom % of at least one element selected from the group consisting of nickel, cobalt, iron, and combinations thereof.

[c8] 8.The barrier coating material of claim 5, further comprising about 5 atom % to about 30 atom % of nickel.

[c9] 9.The barrier coating material of claim 5, further comprising about 1 atom % to about 35 atom % aluminum.

[c10] 10.The barrier coating material of claim 1, wherein the level of rhenium is in the range of about 15 atom % to about 35 atom %.

[c11] 11.The barrier coating of claim 10, further comprising about 1 atom % to

about 35 atom % of at least one element selected from the group consisting of nickel, cobalt, iron, and combinations thereof.

[c12] 12.The barrier coating material of claim 10, further comprising about 1 atom % to about 35 atom % aluminum.

[c13] 13.The barrier coating material of claim 1, wherein the level of ruthenium is in the range of about 10 atom % to about 60 atom %.

[c14] 14.The barrier coating material of claim 13, wherein the level of ruthenium is in the range of about 20 atom % to about 40 atom %.

[c15] 15.The barrier coating material of claim 13, further comprising about 1 atom % to about 35 atom % of at least one element selected from the group consisting of nickel, cobalt, iron, and combinations thereof.

[c16] 16The barrier coating material of claim 14, further comprising about 1 atom % to about 35 atom % aluminum.

[c17] 17.The barrier coating material of claim 16, wherein the level of aluminum is in the range of about 1 atom % to about 15 atom %.

[c18] 18.The barrier coating material of claim 1, wherein the level of rhenium is in the range of about 40 atom % to about 60 atom %.

[c19] 19The barrier coating material of claim 18, further comprising about 1 atom % to about 35 atom % of at least one element selected from the group consisting of nickel, cobalt, iron, and combinations thereof.

[c20] 20.The barrier coating material of claim 18, further comprising about 1 atom % to about 35 atom % aluminum.

[c21] 21.An article for use in a high-temperature, oxidative environment, comprising:
(i)a metal-based substrate, comprising aluminum and other alloy elements;
(ii)a diffusion barrier layer overlying the substrate, said layer comprising
(A)about 15 atom % to about 95 atom % chromium; and

(B)about 5 atom % to about 60 atom % of at least one element selected from the group consisting of rhenium, tungsten, ruthenium, and combinations thereof; and

(iii)an oxidation-resistant coating over the diffusion barrier layer.

[c22] 22.The article of claim 21, wherein the level of chromium in the diffusion barrier layer is in the range of about 50 atom % to about 95 atom %.

[c23] 23.The article of claim 21, wherein the level of chromium is in the range of about 25 atom % to about 60 atom %.

[c24] 24.The article of claim 21, wherein the diffusion barrier layer further comprises about 1 atom % to about 35 atom % of at least one element selected from the group consisting of nickel, cobalt, iron, and combinations thereof.

[c25] 25.The article of claim 21, wherein the diffusion barrier layer further comprises about 1 atom % to about 35 atom % aluminum.

[c26] 26.The article of claim 21, wherein the metal-based substrate is a superalloy, and comprises at least one base metal selected from the group consisting of nickel, cobalt, and iron.

[c27] 27.The article of claim 26, wherein the substrate further comprises at least one alloy element selected from the group consisting of cobalt, molybdenum, titanium, tantalum, carbon, and boron.

[c28] 28.The article of claim 21, wherein the oxidation-resistant coating of component (iii) is an aluminum-rich coating, and the diffusion barrier layer of component (ii) prevents the substantial migration of aluminum from the aluminum-rich coating to the substrate, while also preventing the substantial migration of alloy elements of the substrate into the aluminum-rich coating.

[c29] 29.The article of claim 28, wherein the aluminum-rich coating over the diffusion-barrier layer is an aluminide coating or an overlay coating.

[c30] 30.The article of claim 29, wherein the aluminide coating is selected from the group consisting of nickel-aluminide; noble metal-aluminide, and nickel-noble metal-aluminide.

[c31] 31.The article of claim 30, wherein the noble metal is platinum.

[c32] 32.The article of claim 21, wherein the oxidation-resistant coating of component (iii) is an overlay coating having the composition MCrAl(X), where M is an element selected from the group consisting of Ni, Co, Fe, and combinations thereof; and X is an element selected from the group consisting of Y, Ta, Si, Hf, Ti, Zr, B, C, and combinations thereof.

[c33] 33.The article of claim 21, wherein the oxidation-resistant coating of component (iii) comprises a nickel-chrome alloy.

[c34] 34.The article of claim 33, wherein the nickel-chrome alloy contains about 20 atom % to about 50 atom % chromium, and further comprises at least one element selected from the group consisting of manganese, silicon, and a rare earth element.

[c35] 35.The article of claim 21, wherein the barrier layer has an average thickness in the range of about 1 micron to about 50 microns.

[c36] 36.The article of claim 35, wherein the barrier layer has an average thickness in the range of about 5 microns to about 20 microns.

[c37] 37.The article of claim 21, further comprising a ceramic coating disposed over the oxidation-resistant coating of component (iii).

[c38] 38.The article of claim 37, wherein the ceramic coating is a zirconia-based thermal barrier coating.

[c39] 39.The article of claim 21, wherein the substrate is an airfoil of a gas turbine engine.

[c40] 40.A turbine engine component for use in a high-temperature, oxidative environment, comprising:

(I)a superalloy substrate, comprising a nickel or nickel-cobalt alloy;

(II)a diffusion barrier layer overlying the substrate, said layer comprising

(a)about 15 atom % to about 95 atom % chromium;

(b)about 5 atom % to about 60 atom % of at least one element selected from the group consisting of rhenium, tungsten, ruthenium, and combinations thereof;

(c)about 1 atom % to about 35 atom % of at least one element selected from at least one element selected from the group consisting of nickel, cobalt, iron, and combinations thereof; and

(d)about 1 atom % to about 35 atom % aluminum;

(III)an oxidation-resistant coating over the diffusion barrier layer, comprising a material selected from the group consisting of aluminide materials, MCrAl(X) materials, and nickel-chrome materials,

where M is an element selected from the group consisting of Ni, Co, Fe, and combinations thereof; and X is an element selected from the group consisting of Y, Ta, Si, Hf, Ti, Zr, B, C, and combinations thereof; and

(IV)a zirconia-based thermal barrier coating over the oxidation-resistant coating.

[c41] 41.A method for preventing the substantial migration of aluminum from an aluminum-rich, oxidation-resistant coating into an underlying metal-based substrate in a high-temperature, oxidative environment, comprising the step of disposing a diffusion barrier layer between the substrate and the coating, wherein the diffusion barrier layer comprises:

(a)about 15 atom % to about 95 atom % chromium; and

(b)about 5 atom % to about 60 atom % of at least one element selected from the group consisting of rhenium, tungsten, ruthenium, and combinations thereof.

[c42] 42.The method of claim 41, wherein the diffusion barrier layer is applied over the substrate by a technique selected from the group consisting of electron beam physical vapor deposition (EB-PVD); electroplating, ion plasma deposition (IPD); low pressure plasma spray (LPPS); chemical vapor

deposition (CVD), plasma spray, high velocity oxy-fuel (HVOF), and sputtering.

[c43] 43.The method of claim 41, wherein the metal based substrate comprises a superalloy.

[c44] 44.The method of claim 41, wherein the oxidation-resistant coating is selected from the group consisting of aluminide materials, MCrAl(X) materials, and nickel-chrome materials, where M is an element selected from the group consisting of Ni, Co, Fe, and combinations thereof; and X is an element selected from the group consisting of Y, Ta, Si, Hf, Ti, Zr, B, C, and combinations thereof.

[c45] 45.A method for providing a protective coating system over the surface of a superalloy substrate, comprising the following steps:
(i)applying a diffusion barrier layer overlying the substrate, said layer comprising
(A)about 15 atom % to about 95 atom % chromium; and
(B)about 5 atom % to about 60 atom % of at least one element selected from the group consisting of rhenium, tungsten, ruthenium, and combinations thereof;
(ii)applying an oxidation-resistant coating over the diffusion barrier layer; and then
(iii)applying a zirconia-based thermal barrier coating over the oxidation-resistant coating.

[c46] 46.The method of claim 45, wherein the diffusion barrier layer further comprises:
(C)about 1 atom % to about 35 atom % of at least one element selected from at least one element selected from the group consisting of nickel, cobalt, iron, and combinations thereof; and
(D)about 1 atom % to about 35 atom % aluminum.

[c47] 47.The method of claim 45, wherein the superalloy substrate is an airfoil of a

gas turbine engine.